

**Electronic Health Record-based Quality Indicators for
Ambulatory Care:
Findings from a Review of the Literature**

Final Narrative Report to AHRQ

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I. INTRODUCTION

The purpose of this literature review is to identify a set of quality and safety indicators relevant to ambulatory care settings that incorporate data or functionalities of electronic health records (EHRs) or other advanced health information technology (HIT). The indicators abstracted from relevant literature would provide one source of exemplars for the types of “e-indicators” that could form a future set of national quality measures after full implementation of EHR/HIT systems in the U.S.

This document reflects our final report on the structured literature review and includes the following:

- 1) A narrative with an overview of the literature review methods and a summary of our findings.
- 2) A listing of the indicators we abstracted from the literature. (Appendix B). We have also shared an excel version of this indicator list as an electronic excel file.
- 3) A URL link (and password) that will allow a reader to access the Johns Hopkins University web-based literature management system (known as “Refworks”) that allows a reader to access our search findings, including citations, abstracts, and—in some cases—the PDF file of the articles we have identified in our review to date. (See bottom of page 4).

As a first step toward the development of a standardized set of EHR-based quality performance measures or “e-indicators,” we are reviewing the literature to identify quality and performance indicators derived from EHRs. Our focus is on EHR-based indicators that have been reported for use in single studies and in ongoing quality and safety measurement studies in the ambulatory setting. However, we also include indicators reflecting transitions from ambulatory to other health care settings, such as hospitals and nursing homes. We will emphasize literature reporting on the following categories of indicators (see Appendix A):

- Translation of traditional process and outcome indicators to e-indicators
- HIT-supported process and outcome e-indicators of quality
- HIT system management
- E-iatrogenesis indicators

II. METHODS

Identifying Relevant Studies

Our goal is to develop a comprehensive list of potential quality, safety and performance e-indicators. Therefore, we rely on both published and “gray” literature including conference proceedings, white papers, reports, and websites as our sources for studies. We used a variety of strategies to aid our identification of appropriate literature. First, we conducted a structured search of the published literature using established electronic databases such as PubMed. We identified relevant MeSH terms and other search terms in the following three categories: 1) EHR, EMR, and HIT; 2) Quality Indicators; and 3) Ambulatory or Outpatient setting. These are summarized in Table 1. We first searched for literature that included terms from all three categories. We included both international and U.S. studies. Only studies not published in the English language were excluded.

Table 1: Search Terms

Topic of Interest	MeSH Terms	Search Terms for Title/Abstract, Textword
EHR/EMR, IT	Medical Records Systems , Computerized Management Information Systems	Clinical information system Computerized Patient records Health Information Technology
Quality Indicator	Quality Indicators , Health Care Outcome Assessment (Health Care) Process Assessment (Health Care)	Quality measure Quality Assurance Performance measure Performance indicator
Ambulatory Setting Outpatient Care	Ambulatory Care	Ambulatory Primary care Outpatient General Practice Office-based

We merged separate searches to remove duplicate studies. We then used the following criteria for article selection:

- English language peer-reviewed articles identifiable through electronic databases and reference list of identified articles.
- Based on title and abstract, remove from consideration articles that do not relate specifically to EMR/EHR/HIT, quality measurement or outpatient setting.
- Get full-text of remaining article and remove from consideration those that:
 - were not used or targeted for use in EHR/EMR system,
 - did not include a description of the indicator,
 - did not include outpatient setting.

We also identified articles from reference lists of relevant review articles, from internet searches on websites such as Google Scholar, and based on recommendations from our expert panel and from our own files. We used the same criteria outlined above to determine whether articles identified from these additional sources are relevant for our project.

III. RESULTS

Search Results

We used the MeSH and text term strategies to identify articles through PubMed. In addition, we searched for articles by authors whom we have identified as being active researchers in this area. Our searches resulted in the retrieval of **650** non-duplicative studies (see Table 2). After reviewing the abstracts of these 650 studies, we identified **163** candidate articles that appear promising in terms of identifying quality indicators that have used data from EHR/HIT systems and were selected for full-text review. In addition, a few full-text articles were identified through other means (e.g., Google Scholar). After review of the full-text articles, we abstracted **26** studies that included quality indicators we considered to be in scope for our project.

Table 2: Search Findings from PubMed

Search Strategy	Abstracts Retrieved and Reviewed	Articles selected for Full-text Review
Initial Search <i>Medline MeSH search, merged search results for: "Medical Records systems, Computerized" "Ambulatory Care" and "Health Care Quality, Access and Evaluation"</i>	180	55
Second Search <i>Medline Term search, merged search results for: "Electronic Health Records", "Ambulatory care" and "Quality Indicators" less duplicates from our initial MeSH search results</i>	136	42
More Recent Search (1) <i>Medline Term Search, merged search results for: "Quality Health Indicators" and "Health Information technology" less duplicates from Term Search on: "Quality Health Indicators and" Electronic Health Records".</i>	40	15
More Recent Search (2) <i>Medline Author Search on: "Safran C[Auth]" and related links on: "Electronic Health Records" and "Quality Health Indicators".</i>	145	11
More Recent Search (3) <i>Medline Author Search on: "Morris CJ[Auth]" and related links on: "Electronic Health Records" and "Quality Indicators".</i>	149	40
Total	650	163

Web Page with Article Access

The references to relevant articles identified through these means were included in our Refworks database. To access this system, please go to: www.refworks.com. For those outside the JHU network, please use the group code: "rwjhmi". The login for our account is: "e-indicators2" and our password is "database." A folder called "Excel sampled Articles" contains the listing of references that we have abstracted to date.

Over the course of the project, we observed that studies mostly used traditional HEDIS type measures to evaluate quality within their EHR systems. Given our goal of identifying examples of new indicators that takes advantage of the new capabilities of EHR and HIT systems, we decided instead to focus on less conventional indicators of quality and excluded studies that only used traditional measures of quality.

Indicator Extraction

From the **26** articles we identified through our search, we extracted **129** indicators. For each indicator, the following information were provided:

- A short description of the content area focused on in the indicator
- Measure specification
- Type of measure based on our current e-indicator typology (see Appendix A)
- Short notes on HIT functions and capabilities relevant to measure

Short reference and Refwork #

The specific indicators are presented in Appendix B and have also been shared as an excel spreadsheet.

IV. SUMMARY

Most of the studies we found that were within the scope of our project used traditional HEDIS type indicators. Among the less traditional indicators we found, the most prevalent were indicators that could be implemented in non-EHR environments, but were either made feasible or were enabled through new HIT capabilities (HIT supported indicators). For example, time and date logs permit the evaluation of response times (Safran et al., 1995) and the implementation of a electronic safety events reporting system increased the number of reports and permitted evaluation of the types of safety events that takes place within the system on a continuing basis (Tuttle et al., 2004).

Few studies focused specifically on the development of quality indicators for the new electronic environment. Exceptions include the study by Vogt and colleagues (2004), proposed the development of a prevention index based on time period covered by preventive services. We also identified indicators for a new category of e-indicators, those that are useful for HIT system management, such as measures of the utilization of clinical decision supports or patient portal services made available through HIT systems (van Wijk et al. 2001; Ross et al., 2004). We also identified indicators of data quality within EHR systems, such as the number of blanks found within fields that are expected to be fully populated (e.g, height, weight) within a patient population. E-iatrogenesis, or harm caused by the use of EHRs or HIT, is gaining increasing attention, but identification and measurement of these types of problems within EHRs are done by comparing results from EHR systems and non-EHR systems. In the current literature we reviewed, we found few instances where data from EHRs alone were used to construct measures of e-iatrogenesis.

In summary, this literature review was able to identify a number of examples for the various types of “e-indicators” from our “e-indicator” typology. However, the development of these types of indicators are just beginning and the opportunities and challenges for developing quality indicators for the emerging EHR/HIT environment will need to be more clearly specified before a core set of national “e-indicators” can be developed.

The larger “e-indicator” study (funded by the Commonwealth Fund and the Robert Wood Johnson Foundation) is ongoing. In addition to this literature review funded in-part by this AHRQ contract, other sources of for the project’s final suggest e-indicators will include a survey of early adopters, feedback from a consortium of integrated delivery systems (each with advanced EHR/HIT systems), and an expert advisory panel.

Over the next 6-9 months a final paradigm and suggested framework for the “electronic” measurement of quality and safety in the ambulatory setting will be developed and disseminated as part of this larger project. This larger report (in-part informed by this current sub-contract) will be available to readers of this narrative upon request.

Appendix A.

The main types of “e-indicators” to be developed by this project

(Draft –10/11/06 – Derived by the Commonwealth / RWJF sponsored “e-indicator project)

1) Translational e-indicators: Measures that have been translated from existing “traditional” measurement sets (e.g., HEDIS or NQF standard measures) for application to HIT platforms.

Examples: # of patients with diabetes having an eye care referral, number of in-scope children receiving appropriate immunization.

Note: If a traditional paper-chart derived measure (e.g., blood pressure readings or actual lab values) is expanded from a limited sub-sample of patients to a full patient population, this new application could be considered an “HIT facilitated” measures.” (See #2-A below.)

2) HIT supported e-indicators: Innovative measures that would not be possible on an ongoing basis without one or more components of an HIT system. There are two main sub-categories:

2-A) HIT-facilitated e-indicators: Measures, while not conceptually limited to HIT derived data sources, would not be operationally feasible outside of settings with HIT platforms.

Examples: % of abnormal test results sent to the ordering clinician within 24 hours, % of in-scope cases where clinicians and/or patient receive reminders, % of newly written prescriptions that are filled by patient within 7 days, clinical outcomes of patients based on measures such as BMI, BP, or lab values, % of patient allergy alerts reviewed by patients (via web portal) annually, % of patients attaining functional status targets (input via web).

2-B) HIT enabled e-indicators: Innovative measures that would not generally be possible outside of the HIT context.

These indicators reflect measures linked to unique HIT capabilities such as CPOE, CDSS, biometrics devices, or patient web portals. These measures may involve only one HIT component or they may require the interaction of two or more components (e.g., CPOE and CDSS interaction, CPOE and EHR, or web-portal and EHR).

Examples: % of in-scope patients where real-time CDSS modules are appropriately applied to support the diagnostic process, % of real-time alerts by-passed by clinician, % of CHF patients with daily e-monitored weight gain greater than x pounds where responsible clinician acts upon finding within y hours, % of patients who open their message regarding abnormal test results.

Note: HIT supported e-indicators can focus on process, end-results/outcomes, or patient centered issues. They can be retrospective or real time. They can focus on individual patient care quality or safety or involve population based improvement. (See discussion of these and other measurement dimensions in domain outline.)

3) e-indicators for HIT system management: Measures required to implement, manage and evaluate HIT systems.

These measures are intended primarily for use by an organization or other entity (e.g., a community) to improve the effectiveness and efficiency of its HIT system. They can also be used by an external body (e.g., a payer) to evaluate an HIT system being applied to their population of interest.

Examples: EHR item completion rates, attainment of community interoperability targets, CDSS algorithms accuracy, ease of access of population based measures that are maintained in free-text section of EHR, HIT functionality scores (similar to NCQA physician practice connection)

4) “e-iatrogenesis” e-indicators: Measures of actual or potential patient harm caused at least in part by the application of health information technology.

These indicators assess the degree to which unanticipated quality and safety problems arise related to the use of one or more components of an EHR/HIT system. These issues may involve, human (provider or patient), technical, or organizational/system factors. They may involve errors of commission or omission.

Examples: % of patients receiving incorrect medications or procedures due to HIT related errors in the CPOE process, % patients experiencing a degree of harm (can be rated using various existing scales) due to unanticipated care delivery event, % CDSS errors (either type 1 or type 2) for a type of case, human/machine interaction errors that lead to incorrect information entry, # patients receiving other patients orders.

Note: This measure is designated separately due to its signal importance for those concerned with quality and safety in the HIT context. However, one could consider this a sub-category of #3 above as these measures can be used to help improve the HIT implementation process. Also, measurement of “traditional” errors, such as a clinician not acting on information that they receive, or the wrong clinical action taken, would not necessarily be considered a type of e-iatrogenesis and would more appropriately be categorized elsewhere under this schema (probably under #1 or #2 above).

Appendix B. Indicator List

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: CD4 count]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: Begin AZT or DDI]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: Complete blood count]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: Change AZT dose]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: PCP prophylaxis]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical alerts for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Alert: All alerts]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: toxoplasmosis titre]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: tuberculin skin test]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: pneumovax]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: H influenzae vaccine]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: Ophthalmologic referral]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: tetanus shot]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: pap test]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Response times of clinicians to clinical reminders for HIV patients in primary care	Time from message generation to clinical action noted in EMR (clinician documented action, result from recommended action recorded, condition prompting alert/reminder no longer present, alert marked inappropriate or inapplicable) [Reminder: All reminders]	HIT supported	basic EMR (with scheduling and date/time stamp), alert/reminder system, CPOE	Safran et al. 1995. Lancet 346:341-346. (Refwork#14)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) use of an oral/topical NSAID for 3 months or more in a patient with hypertension and/or CHF; Denominator: (Outcome) GP practice or hospital contact due to CHF and/or fluid overload	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) use of an ACE inhibitor without monitoring the creatine level before starting treatment, within 6 weeks of commencement, and at least annually thereafter; Denominator: (Outcome) Raised serum creatinine.	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an ACE inhibitor without monitoring the potassium level before starting treatment, within 6 weeks of commencement, and at least annually thereafter; Denominator: (Outcome) Hyperkalaemia (potassium level > 5.5 mmol/l)	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of a long half life hypnotic-anxiolytic; Denominator: (Outcome) fall or broken bone	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) In the absence of any contraindication, failing to prescribe a beta-blocker in a patient with a history of an MI; Denominator: (Outcome) A second MI	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an oral/topical NSAID for 1 week or more in a patient with a history of peptic ulcers or GI bleeding; Denominator: (Outcome) Dyspepsia or upper GI bleed, GI perforation, GI ulcer or anaemia	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) In the absence of any contraindication, failing to prescribe an ACE inhibitor to a patient with known CHF; Denominator: (Outcome) GP contact or hospital admission due to worsening symptoms of CHF	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of carbamazepine without a full blood count before treatment initiated and periodically during treatment; Denominator: (Outcome) Blood dyscrasias	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an inhaled short acting bronchodilator more than once daily or at night in an asthmatic patient with no regular inhaled "preventer" therapy (corticosteroid or cromoglycate or nedocromil); Denominator: (Outcome) GP practice or hospital contact due to asthma symptoms	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of warfarin without monitoring the INR before initiation of treatment, on alternate days in the early days of treatment, then at longer intervals, then at least every 3 months thereafter; Denominator: (Outcome) A minor or major haemorrhagic event	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of a potassium wasting diuretic without concurrent use of a potassium supplement or concurrent use of a potassium sparing diuretic or monitoring the potassium level at least annually; Denominator: (Outcome) Hypokalaemia (potassium level < 3.0 mmol/l)	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) In the absence of any contraindication, failing to prescribe aspirin in a patient with a history of MI; Denominator: (Outcome) A second MI	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an inhaled steroid by high dose metered dose inhaler without usage of a spacer device; Denominator: (Outcome) Oral thrush/ dysphonia	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of a thyroid agent without monitoring the T4 or thyroid stimulating hormone within 6 weeks of initiation of treatment and at least every 12 months thereafter; Denominator: (Outcome) GP practice or hospital contact due to hyperthyroidism	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Concurrent use of warfarin and an oral/ topical NSAID without monitoring the INR within 10 days; Denominator: (Outcome) A minor or major haemorrhagic event	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Concurrent use of warfarin and an antibiotic without monitoring the INR within 5 days; Denominator: (Outcome) A minor or major haemorrhagic event	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an anticholinergic agent in a patient with a history or current diagnosis of benign prostatic hypertrophy; Denominator: (Outcome) Acute urinary retention	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of a statin without monitoring the liver function before starting treatment, within 3 months of commencement and then at 6 monthly intervals thereafter; Denominator: (Outcome) Serum transaminase concentrations elevated to three times the upper limit of the reference range or clinical jaundice	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Prescribing beta-blocker eye drops to a patient with a history of asthma or COAD; Denominator: (Outcome) GP or hospital contact due to a deterioration in symptoms, or an acute exacerbation, of asthma or COAD	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Refwork#10)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Rework #)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Continued use of a previously established dose of digoxin without assessing the digoxin level in a patient presenting with any of the following symptoms— anorexia, nausea and vomiting, diarrhoea, visual disturbances, fatigue; Denominator: (Outcome) Drowsiness or confusion or arrhythmias or delirium or hallucinations	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of an oral corticosteroid for at least 3 months in a patient with a history or concurrent diagnosis of peptic ulcers and/ or GI bleeding; Denominator: (Outcome) Dyspepsia or upper GI bleed, GI perforation, GI ulcer or anaemia	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of digoxin in a patient with CHF, with heart block or advanced bradycardia; Denominator: (Outcome) GP practice or hospital contact due to CHF and/ or heart block	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of metoclopramide in a patient with a history of Parkinson's disease; Denominator: (Outcome) Worsening of Parkinson's disease symptoms, e.g., attacks of rigidity or tremor	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Use of imipramine in a patient with a history of current diagnosis of bladder atony resulting from diabetes; Denominator: (Outcome) Acute urinary retention	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Addition of amiodarone to the treatment of a patient already prescribed digoxin without reducing the digoxin dosage by initially one third to one half and subsequent monitoring of the digoxin level; Denominator: (Outcome) Anorexia or nausea and vomiting or diarrhoea or visual disturbances or fatigue or drowsiness or confusion or arrhythmias or delirium or hallucinations	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181-185. (Rework#10)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Concurrent use of an ACE inhibitor and either a potassium sparing diuretic or a potassium supplement without monitoring the potassium level at least annually; Denominator: (Outcome) Hyperkalaemia (potassium level > 5.5 mmol/l)	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181- 185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Addition of amiodarone to the treatment of a patient already prescribed warfarin without reducing the warfarin dose and closely monitoring the INR; Denominator: (Outcome) a minor or major haemorrhagic event	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181- 185. (Refwork#10)
Preventable Drug Related Morbidity (PDRM) Indicators	Numerator: (Pattern of care) Continued use of a previously established dose of phenytoin without assessing phenytoin level in a patient experiencing an altered seizure pattern; Denominator: (Outcome) Hospital admission due to loss of seizure control	HIT supported	basic EMR, specialized data retrieval software (MIQUEST)	Morris et al. 2004. Qual Saf Health Care 2004;13:181- 185. (Refwork#10)

PI Score for specific service = $100 \times \frac{\text{covered months}}{\text{target period months - excluded months}}$; Numerator for each service = total number of covered person-month within target period - the portion of target period within which they are covered by the service for therapeutic purposes. covered person-month = eligible for the service during the month and appropriately covered; uncovered person-month = eligible for the service during the month, but not covered; excluded months (not counted in the PI calculations) = covered months derived from services delivered for therapeutic or diagnostic reasons or from services for which the individual was not eligible for other reasons (e.g., age); Denominator for each service = total number of months eligible for service within target period - the portion of target period within which they are covered by the service for therapeutic purposes.

The Prevention Index: person-time assessment of proportion of a service interval appropriately covered (i.e., the proportion of months in an observation period covered by a recommended service); summary assessment of 24 preventive services.

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Active computer time: the amount of time the EMR system requires for data input or use during consultation	Total time spent in computer-related activities (all keyboard actions, mouse movements, period of inactivity of 10 seconds or less to account for reading on-screen information) during a single consultation	HIT system management	basic EMR, automated data logging of system usage capability	Blignaut et al. 2001. Computers in Nursing 19:130-136. (Refwork#2)
Rates of Medication Data Errors in EMR	Numerator: Number of correct medication records (definition: clinician perspective, medication, schedule, and dose); Denominator: Total number of medication records	HIT system management	basic EMR + medical decision support system (MDSS).	Wagner and Hogan. 1996. Journal of the American Medical Informatics Association. 3:234-244. (Refwork#17)
Rates of Medication Data Errors in EMR	Numerator: Number of correct medication records (definition: clinician perspective, medication only); Denominator: Total number of medication records	HIT system management	basic EMR + medical decision support system (MDSS).	Wagner and Hogan. 1996. Journal of the American Medical Informatics Association. 3:234-244. (Refwork#17)
Rates of Medication Data Errors in EMR	Numerator: Number of correct medication records (definition: Medicinal Decision-Support System, MDSS, medication only); Denominator: Total number of medication records	HIT system management	basic EMR + medical decision support system (MDSS).	Wagner and Hogan. 1996. Journal of the American Medical Informatics Association. 3:234-244. (Refwork#17)
Rates of Medication Data Errors in EMR	Average number of medications per patient for which no medication record exists	HIT system management	basic EMR + medical decision support system (MDSS).	Wagner and Hogan. 1996. Journal of the American Medical Informatics Association. 3:234-244. (Refwork#17)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Rates of Medication Data Errors in EMR	Numerator: Number of patient medication lists that were both complete and correct; Denominator: Total number of patient medication lists	HIT system management	basic EMR + medical decision support system (MDSS),	Wagner and Hogan. 1996. Journal of the American Medical Informatics Association. 3:234-244. (Refwork#17)
Erythropoietin Prescription Rates in cancer patients with anemia (Hgb level < 12g/dL) with real-time clinical reminder	Numerator: Patients prescribed or treated with an erythropoietin drug [after computer alert]; Denominator: Patients with a recorded Hgb < 12 g/dL at any time 14 days before the visit and was not given erythropoietin before the visit	HIT supported	basic EMR, reminder system, CPOE	Kralj et al. 2003. Am J Med Qual 18:197-203. (Refwork#343)
Medication costs associated with Electronic Prescribing System with Integrated Decision Support in Primary Care	Average drug costs per prescription for new prescriptions (costs includes original prescription plus all refills obtained for medication during the 12 month follow-up period)	HIT system management	basic EMR, CDSS, CPOE	McMullin et al. 2005. Journal of Managed Care Pharmacy 11:322-332. (Refwork#346)
Medication costs associated with Electronic Prescribing System with Integrated Decision Support in Primary Care	Average drug costs per prescription for all prescriptions (includes new prescriptions plus refills for medications prescribed prior to CDSS implementation in the 12 month follow-up)	HIT system management	basic EMR, CDSS, CPOE	McMullin et al. 2005. Journal of Managed Care Pharmacy 11:322-332. (Refwork#346)
Medication costs associated with Electronic Prescribing System with Integrated Decision Support in Primary Care	Average drug costs per member per month for all new prescriptions (costs includes original prescription plus all refills obtained for medication during the 12 month follow-up period)	HIT system management	basic EMR, CDSS, CPOE	McMullin et al. 2005. Journal of Managed Care Pharmacy 11:322-332. (Refwork#346)
Medication costs associated with Electronic Prescribing System with Integrated Decision Support in Primary Care	Average drug costs per member per month for all prescriptions (includes new prescriptions plus refills for medications prescribed prior to CDSS implementation in the 12 month follow-up)	HIT system management	basic EMR, CDSS, CPOE	McMullin et al. 2005. Journal of Managed Care Pharmacy 11:322-332. (Refwork#346)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Quality of documentation of medical records and after care instructions for febrile children	For each of 21 essential items (elements needed to negotiate process-of-care rules in the clinical guideline); percentage of charts with the essential item documented	HIT system management	Guideline embedded EMR, with software program that allows separate rule modules to be created	Schriger et al. 2000 J Am Med Inform Assoc 7(2):186-95. (Refwork#354)
Quality of documentation of medical records and after care instructions for febrile children	Overall documentation score: average documentation percentage across all 21 items	HIT system management	Guideline embedded EMR, with software program that allows separate rule modules to be created	Schriger et al. 2000 J Am Med Inform Assoc 7(2):186-95. (Refwork#354)
Appropriateness of testing and treatment decisions and diagnoses	Numerator: Number of appropriate decisions (whether documented action matched indication, e.g., indicated--given, not indicated--not given); Denominator: Total number of decisions	HIT supported	Guideline embedded EMR, with software program that allows separate rule modules to be created	Schriger et al. 2000 J Am Med Inform Assoc 7(2):186-95. (Refwork#354)
Rates of contraindicated (drug-drug, drug-laboratory, and/or drug-disease) prescriptions	Numerator: Number of patients prescribed a contraindicated drug; had a contraindicated disease; or did not receive adequate monitoring (i.e., in violation of either a drug-drug, drug-disease or drug-laboratory warning). Denominator: Number of patients prescribed a drug with any black box warning (drug-drug warning, drug-disease warning, and/or drug-laboratory warning)	HIT supported	basic EMR, CPOE, CDSS	Lasser et al. 2006 Arch Intern Med 166(3):338-44. (Refwork# 351)
Rates of adverse drug events due to contraindicated drugs	Numerator: Number of adverse drug events due to contraindicated drug; Denominator: Number of patients who received a contraindicated prescription (one that violated a black box warning)	HIT supported	basic EMR, CPOE, CDSS	Lasser et al. 2006 Arch Intern Med 166(3):338-44. (Refwork# 351)
Adverse Drug Events (ADEs) in geriatric ambulatory patients.	Numerator: Drug-related incidents categorized by clinicians manually as ADEs; Denominator: Drug-related incidents identified via manual and computer-generated signals (elevated drug levels, abnormal lab values, antidote meds and diagnoses that could reflect ADE, automated "free-text" review of clinic notes)	HIT supported	basic EMR, computer-based "free text" search capability	Field et al. 2004 J Am Med Inform Assoc 11(6):492-8 (Refwork#402)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Preventable ADEs in geriatric ambulatory patients.	Numerator: Drug-related incidents categorized by clinicians manually as preventable ADEs; Denominator: Drug-related incidents identified via manual and computer-generated signals (elevated drug levels, abnormal lab values, antidote meds and diagnoses that could reflect ADE, automated "free-text" review of clinic notes)	HIT supported	basic EMR, computer-based "free text" search capability	Field et al. 2004. J Am Med Inform Assoc 11(6):492-8 (Refwork#402)
Anticoagulant treatment quality (% time in target therapeutic range)	Numerator: Time within target therapeutic range (INR= 2.1-3.0) within first 90 days of treatment; Denominator: Total time under warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)
Anticoagulant treatment quality (% time in subtherapeutic range)	Numerator: Time within subtherapeutic range (INR <2.1) within first 90 days of treatment; Denominator: Total time under warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)
Anticoagulant treatment quality (% time in supertherapeutic range)	Numerator: Time within supertherapeutic range (INR > 3.0) within first 90 days of treatment; Denominator: Total time under warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)
Anticoagulant treatment quality (% tests in target therapeutic range)	Numerator: Number of INR tests in therapeutic range (INR= 2.1-3.0) within first 90 days of treatment; Denominator: Total number of INR monitoring tests performed for patients on warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)
Anticoagulant treatment quality (% tests in subtherapeutic range)	Numerator: Number of INR tests in subtherapeutic range (INR <2.1) within first 90 days of treatment; Denominator: Total number of INR monitoring tests performed for patients on warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)
Anticoagulant treatment quality (% tests in supertherapeutic range)	Numerator: Number of INR tests in subtherapeutic range (INR >3.0) within first 90 days of treatment; Denominator: Total number of INR monitoring tests performed for patients on warfarin treatment within first 90 days of treatment	HIT supported	basic EMR	Nilsson et al. 2004. 21(6):612-6. (Refwork#393)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Rework #)
Cardiovascular disease prevention: risk reduction process measures	Numerator: number of patients with no risk factors who were screened within the last five years; Denominator: all patients 30 or older not known to have any cardiovascular risk factor	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction process measures	Numerator: Number of patients who were monitored: within 6 months for patients with CVD and/or diabetes and/or hypertension and within 12 months for all other patients; Denominator: all patients with >=1 risk factor for CVD	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction process measures	Change in use of anti-thrombotic medication from first contact to first monitoring cycle among patients with CVD	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction process measures	Change in use of ACE-inhibitors/ARBs from first contact to first monitoring cycle among hypertensive diabetic patients or patients with CHF	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction process measures	Change in use of lipid-lowering drugs from first contact to first monitoring cycle among dyslipidaemic patients with CVD or diabetes	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction process measures	Change in use of beta-blockers from first contact to first monitoring cycle among patients post MI	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Rework #)
Cardiovascular disease prevention: risk reduction outcome measures	Change in systolic BP from first contact to first monitoring cycle among hypertensive patients	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction outcome measures	Change in diastolic BP from first contact to first monitoring cycle among hypertensive patients	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction outcome measures	Change in systolic BP from first contact to first monitoring cycle among hypertensive diabetic patients	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction outcome measures	Change in diastolic BP from first contact to first monitoring cycle among hypertensive diabetic patients	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction outcome measures	Change in HbA1c from first contact to first monitoring cycle among diabetic patients	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)
Cardiovascular disease prevention: risk reduction outcome measures	Change in LDL from first contact to first monitoring cycle among patients with CVD or diabetes	HIT supported	basic EMR	Rabinowitz and Tamir 2005. Eur J Cardiovasc Prev Rehabil 12:56-62. (Rework#391)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (ReWorks #)
Percent medication error by severity category in CPOE facility	numerator: number of medication errors per month reported in CPOE facility. Denominator: Monthly total dosages reported in CPOE facility, # errors/100,000 total doses	HIT supported	CPOE	Zhan et al. 2006 Am J Health Syst Pharm 63:353-358 (ReWorks# 1)
Percent errors per 100,000 doses in CPOE facility	numerator: number of medication errors per month reported in CPOE facility. Denominator: Monthly total dosages reported in CPOE facility, # errors/100,000 total doses	E-iatrogenesis	CPOE	Zhan et al. 2006 Am J Health Syst Pharm 63:353-358 (ReWorks# 1)
Percent fatal errors per 100,000 doses in CPOE	numerator: number of fatal errors per month reported in CPOE facility. Denominator: Monthly total dosages reported in CPOE facility	E-iatrogenesis	CPOE	Zhan et al. 2006 Am J Health Syst Pharm 63:353-358 (ReWorks# 1)
Percent error type related to CPOE	numerator: number of types of medication errors per month reported in CPOE facility. Denominator: Monthly total dosages reported in CPOE facility	E-iatrogenesis	CPOE	Zhan et al. 2006 Am J Health Syst Pharm 63:353-358 (ReWorks# 1)
Prescription rate of Antiplatelet drugs in Diabetics.	Numerator: Number of patients with antiplatelet drug prescription; Denominator: Number of High risk diabetic patients	HIT supported	EMR, alert/reminder system/prompt	Filippi et al. 2003 Diabetes Care 26:1497-1500 (ReWorks# 4)
Prescription rate of Antiplatelet drugs in Diabetics with one risk factor	Numerator: Number of patients with antiplatelet drug prescription; Denominator: Number of High risk diabetic patients with one risk factor	HIT supported	EMR, alert/reminder system/prompt	Filippi et al. 2003 Diabetes Care 26:1497-1500 (ReWorks# 4)
Prescription rate of Antiplatelet drugs in Diabetics with two risk factors	Numerator: Number of patients with antiplatelet drug prescription; Denominator: Number of High risk diabetic patients with two risk factors	HIT supported	EMR, alert/reminder system/prompt	Filippi et al. 2003 Diabetes Care 26:1497-1500 (ReWorks# 4)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (RefWork #)
Medication management among patients with schizophrenia	Numerator: Number of patients classified as receiving doses above recommended range if the daily dose was above upper limit of recommended range for that drug (indicator of poor quality); Chlorpromazine (300-600 mg/day for outpatients) for both oral and depot meds was the maximum range; Denominator: Number of outpatients with diagnosis of schizophrenia and receiving medications	HIT supported	order entry functions, automated queries.	Owen et al. 2004 JAMIA 11:351-357 (RefWork# 485)
Medication management among patients with schizophrenia	Numerator: Number of medication changed if GAF score was low or decreased; Denominator: Number of outpatients with diagnosis of schizophrenia with low or decreased GAF score.	HIT supported	order entry functions, automated queries.	Owen et al. 2004 JAMIA 11:351-357 (RefWork# 485)
Screening Rate of smoking status	Numerator:patients with smoking status documented in the electronic medical records in the first two days of each month. Denominator: Total number of patients seen during the first two days of each month.	HIT supported	EMR, Prompts /Reminders,	Spencer et al. 1999 Arch Fam Med 8:18-22 (RefWorks# 15)
Clinician interaction with decision support system	Numerator: Number of patients for whom clinicians entered a new blood pressures and updated the advisory; Denominator: Number of patients with a diagnosis of primary hypertension for whom advisories were generated by the decision support system	HIT system management	EMR, CDSS	Goldstein et al, 2004 (RefWorks# 484)
Clinician interaction with decision support system	Numerator: Number of patients for whom clinicians interacted with the advisory screen in any way; Denominator: Number of patients with a diagnosis of primary hypertension for whom advisories were generated by the decision support system	HIT system management	EMR, CDSS	Goldstein et al, 2004 (RefWorks: 484).
Treatment and care of new depression cases	Numerator: Number of new cases for whom antidepressant medications were prescribed or filled within one month and six months after index visit; Denominator: All cases of new-onset depression identified within specified period by automated query	HIT supported	Integrated EMR (meds, diagnoses, etc.) with automated query function (VA system)	Kramer et al. 2003. Joint Commission Journal on quality and safety 29, 9, 479-489 (Refworks #9)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refworks #)
Treatment and care of new depression cases	Numerator: Number of new cases for whom a therapeutic dose of antidepressant medication was prescribed or filled within one month and six months after index visit; Denominator: All cases of new-onset depression identified within specified period by automated query	HIT supported	Integrated EMR (meds, diagnoses, etc.) with automated query function (VA system)	Kramer et al. 2003. Joint Commission Journal on quality and safety 29, 9, 479-489 (Refworks #9)
Treatment and care of new depression cases	Numerator: Number of new cases for whom at least one psychotherapy session occurred within six months after index visit; Denominator: All cases of new-onset depression identified within specified period by automated query	HIT supported	Integrated EMR (meds, diagnoses, etc.) with automated query function (VA system)	Kramer et al. 2003. Joint Commission Journal on quality and safety 29, 9, 479-489 (Refworks #9)
Treatment and care of new depression cases	Numerator: Number of new cases for whom antidepressant medication were prescribed or filled or at least one psychotherapy session occurred within six months after index; Denominator: All cases of new-onset depression identified within specified period by automated query	HIT supported	Integrated EMR (meds, diagnoses, etc.) with automated query function (VA system)	Kramer et al. 2003. Joint Commission Journal on quality and safety 29, 9, 479-489 (Refworks #9)
Treatment and care of new depression cases	Numerator: Number of new cases seen in a mental health setting within six months after index; Denominator: All cases of new-onset depression identified within specified period by automated query	HIT supported	Integrated EMR (meds, diagnoses, etc.) with automated query function (VA system)	Kramer et al. 2003. Joint Commission Journal on quality and safety 29, 9, 479-489 (Refworks #9)
Optimal level of control for hyperglycemia in patients with diabetes	Numerator: (based on ideal goals set by ADA), Patients with HbA1c <7%; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Optimal level of control for hypertension in patients with diabetes	Numerator: (based on ideal goals set by ADA), Patients with blood pressure <130/80; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refworks #)
Optimal level of control for hyperlipidemia in patients with diabetes	Numerator: (based on ideal goals set by ADA), Patients with LDL level <100 mg/dL; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Adequate level of control for hyperglycemia in patients with diabetes	Numerator: (based on current NCQA recommendations), Patients with HbA1c <8%; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Adequate level of control for hypertension in patients with diabetes	Numerator: (based on current NCQA recommendations), Patients with blood pressure <140/90; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Adequate level of control for hyperlipidemia in patients with diabetes	Numerator: (based on current NCQA recommendations), Patients with LDL level <130 mg/dL; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Appropriate use of medication for hyperglycemia in patients with diabetes	Numerator: Patients on treatment medication for HbA1c Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period and identified as having inadequate control of HbA1c	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Appropriate use of medication for hypertension in patients with diabetes	Numerator: Patients on treatment medication for specified risk factor; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period and identified as having inadequate control of blood pressure	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Appropriate use of medication for hyperlipidemia in patients with diabetes	Numerator: Patients on treatment medication for specified risk factor; Denominator: patients with diagnosis of diabetes (ICD-9 code 250.XX) active over specified time period and identified as having inadequate control of LDL	HIT supported	National electronic health record network	Gill et al. 2006. Am J Med Qual 21:13-17 (Refworks #6)
Completeness of EMR data	Percentage of blanks for fields which can be expected to contain data for all patients (gender, age, marital status, height, weight, occupation, lifestyle information such as smoking, alcohol use)	HIT system management	Qtool extraction program	Treweek. 2003. BMC Health Serv Res 3(1):10 (Refworks #483)
Use of web-based EMR functions in patients with congestive heart failure	Numerator: Number of patients who used the SPPARO/Electronic Messaging system; Denominator: Number of patients given access to SPPARO	HIT system management	patient portal for EMR	Ross et al. 2004. J Med Internet Res 6(2): e12. (Refworks# 407)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Use of web-based EMR functions in patients with congestive heart failure	Numerator: Number of patient hit day (defined as a day that a particular patient used a component of SPPARO accessing the same component multiple times on the same day) still equal one patient hit day); Denominator: Number of days during observation period	HIT system management	patient portal for EMR	Ross et al. 2004. J Med Internet Res 6(2): e12. (Refwork# 407)
Use of web-based EMR functions in patients with congestive heart failure	Numerator: Number of patients viewing specific content of SPPARO such as clinical notes, lab results, radiology results, educational guides; Denominator: Number of patients given access to SPPARO	HIT system management	patient portal for EMR	Ross et al. 2004. J Med Internet Res 6(2): e12. (Refwork# 407)
Use of web-based EMR functions in patients with congestive heart failure	Numerator: number of electronic messages sent to practices through SPPARO by content category (appointment scheduling, medication refill, questions about medications, get test results, report illness; get help interpreting test results); Denominator: Number of patients given access to SPPARO	HIT system management	patient portal for EMR	Ross et al. 2004. J Med Internet Res 6(2): e12. (Refwork# 407)
Electronic message volume	Number of electronic messages sent to provider per month	HIT system management	patient portal for EMR	Ross et al. 2004. J Med Internet Res 6(2): e12. (Refwork# 407)
Provider adherence to the 5A tobacco intervention activities recommended by USPHS	Numerator: Patients who received all five (5A) smoking intervention activities recommended by USPHS; Denominator: Probable current smokers (any patient identified as a smoker in a chart note in the past 3 years who had not subsequently been noted to quit)	HIT supported	health maintenance grid within EMR	Conroy et al. 2005. Nicotine Tobacco Research 7: S35-43 (Refwork# 411)
Performance of decision support system for medication management of hypertensive patients	Numerator: Number of hypertensive patients actually prescribed the specific drug class recommended by the DSS; Denominator: Number of hypertensive patients recommended a specific drug class by the DSS	HIT system management	CDSS	Persson et al. 2000. J Intern Med 247:87-93. (Refwork# 12)
Performance of decision support system for medication management of hypertensive patients	Numerator: Number of hypertensive patients with specified medical history or co-morbidities actually prescribed the specific drug class recommended by the DSS; Denominator: Number of hypertensive patients with specified medical history or co-morbidities recommended a specific drug class by the DSS	HIT system management	CDSS	Persson et al. 2000. J Intern Med 247:87-93. (Refwork# 12)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (ReWork #)
Utilization rates for a clinical decision support system	Numerator: Number of times Bloodlink, a decision support system on blood test ordering, was used by clinicians; Denominator: Number of patient encounters for clinicians with access to Bloodlink	HIT system management	CDSS	van Wijk et al. 2001. Ann Intern Med 134:274-281 (ReWork# 344)
Clinical chemistry and microbiology test order rates	Numerator: Number of clinical chemistry and microbiology tests ordered; Denominator: Number of patient encounters for clinicians with access to Bloodlink	HIT system management	CDSS	van Wijk et al. 2001. Ann Intern Med 134:274-281 (ReWork# 344)
Safety event reporting	Numerator: Number of medication/infusion events reported within specified period; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)
Safety event reporting	Numerator: Number of adverse clinical events reported within specified period; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)
Safety event reporting	Numerator: Number of falls reported within specified period; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)
Safety event reporting	Numerator: Number of events that resulted in patient harm; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)
Safety event reporting	Numerator: Number of events related to "near misses"; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)
Safety event reporting	Numerator: Number of events related to unsafe conditions; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (ReWork# 358)

Indicator Description	Measure Specification	Type of Measure	HIT capability	Reference (Refwork #)
Safety event reporting	Numerator: Number of events that resulted in no patient harm; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (Refworks# 358)
Safety event reporting	Numerator: Number of events due to human factors; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (Refworks# 358)
Safety event reporting	Numerator: Number of events due to system factors; Denominator: Number of events reported through the electronic reporting system within specified period	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (Refworks# 358)
Safety event reporting	Number of safety events reported each month through the electronic safety reporting system	HIT supported	electronic safety event reporting system	Tuttle et al. 2004 Qual Saf Health Care 13:281-286 (Refworks# 358)
Colorectal screening rates with decision aid use	Numerator: Number of patients with record of screening test ordered and completed for either fecal occult blood test, colonoscopy, sigmoidoscopy or barium enema within 6 months after decision aid use; Denominator: Number of adult patients 50 years or older who used the patient decision support aid for colorectal screening.	HIT system management	CDSS	Kim et al. 2005. BMC Medical Informatics and Decision Making 5:36. (Refworks# 352)
Rates of up-to-date colorectal screening	Numerator: Number of patients with up-to-date status for colorectal screening (fecal occult blood test in past year, sigmoidoscopy or barium enema in past 5 years, or colonoscopy in past 10 years); Denominator: Number of adult patients 50 years or older	HIT supported	CDSS	Kim et al. 2005. BMC Medical Informatics and Decision Making 5:36. (Refworks# 352)